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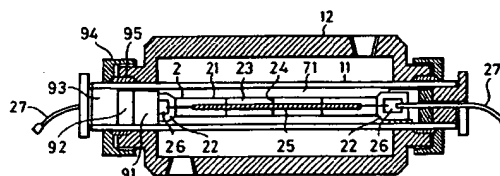
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(54) **FLUID HEATER.**

(57) This invention consists in radiant heat in a fluid heater having an increased area for receiving radiant heat in a high energy density structure which is easy in maintenance and capable of preventing entrance of contamination source. For attaining the object, a transparent internal pipe (11) of a fluid heating pipe unit opening at both ends is arranged in an external pipe (12) of said unit having an inlet and outlet for fluid flow on the wall thereof in such manner that the former may be spaced from the inner wall of the latter, both pipes (11, 12) are sealingly connected to each other at respective ends, and an electric heater (2) is arranged in the internal pipe while spaced from the inner wall of said pipe and is supported by supporting members (91, 92) at both ends.

FIG. 8(A)



EP 0 570 586 A1

## Technical Field

The present invention relates to a fluid heater for resonance-heating a fluid to be heated by radiant heat and, more particularly, a fluid heater capable of appropriately carrying out heating and temperature control such as heating and temperature control of etching solution and resist removing solution after cleaning wafers made of silicon or the like in manufacturing processes of semiconductor devices, and heating and temperature control of oils for foodstuffs while the fluid to be heated is being supplied.

## Background Art

An example of appropriate use of a fluid heater is described referring to a temperature control unit of a semiconductor wafer treating solution shown in Fig.10. In Fig.10, a treating bath 100 is filled with treating solution 200, which is forced to flow in a teflon piping 400 by a pump 300, heated by a fluid heater 500, filtered by a filter 600 to remove foreign substances contained in the treating solution, and returned to the treating bath 100. The temperature of treating solution 200 of the treating bath 100 is detected by a sensor 700 and the controller 800 controls the fluid heater 500 so that the detected temperature approaches a preset temperature. In the above drawing, numerals 510 denote a box which incorporates the fluid heater 500. Numerals 900 denote a semiconductor wafer.

Figs.11 (A) and 11 (B) are respectively a perspective view and a sectional view of a conventional fluid filter. Specifically, an electric heater 2 is provided on an external periphery of a fluid heating pipe unit 1 to heat fluid C introduced from an inlet pipe 31 and discharge it from an outlet pipe 32. In this example, the fluid heater 2 comprises, in an order from the inside, a fluid heating pipe unit 1, a clearance 7, an electric heater 2 formed with eight parallel members such as nichrome wire, kanthal wire and others, and insulation material 4.

In this case, the above described conventional fluid heater includes a problem as described below. The fluid heater heats fluid by radiant heat and, in this case, a temperature increasing rate of fluid to be heated by radiant heat is proportional to an energy density of absorption wavelength band of heated fluid (penetration energy in a unit time in a unit area) if a radiation area is fixed and proportional to the radiation area if the energy density is fixed. In other words, the energy density need be increased or the radiation area need be expanded to raise the heating rate.

By the way, the higher the temperature of the electric heater 2 is, the higher the energy density can be increased according to the Stefan-Boltz-

mann law saying "the energy density is proportional to a fourth power of the temperature of an object which emits radiant heat". However, unless the energy is absorbed by the fluid heating pipe unit 1 even though only the electric heater 2 is set to a high temperature, only the temperature of the electric heater 2 rises to result in melting loss. Otherwise, even though the radiation area is expanded by increasing the number of members of the electric heater 2, the electric heater 2 is short-circuited to result in melting loss. In addition, part of radiant heat from the external periphery of the electric heater 2 is radiated in four directions of insulation material and absorbed by insulation material 4 and therefore it does not contribute to heating of fluid.

On the other hand, the radiation area can be expanded to raise the heating rate but a larger fluid heating pipe unit 1 is required and the fluid heater need be large-sized. It is difficult to conduct heat to fluid which flows in a central part of fluid flowing in the fluid heating pipe unit 1 and consequently the heating rate is not raised.

sulfuric acid, hydrochloric acid and hydrofluoric acid are heated up to approximately 50~150 °C in the fluid heater 500 for use in cleaning, etching and removing resist and used but technologies in relation to corrosion resistance of the fluid heater 500 and a low degree of contamination of heated chemical solution are unknown.

For example, an embodiment disclosed in the Patent Application Disclosure No.116246-1986 is a fluid heater differing from the above described prior art. Though not shown, the configuration of this embodiment is such that a fluid heating pipe unit is provided on the external periphery of the electric heater. Specifically, this fluid heater comprises an electric heater serving as an infrared radiation member and crystal glass forming an internal pipe of the fluid heating pipe unit which are integrated. In such configuration, when the infrared radiation member is to be replaced, substances adhering to new components are brought into the passage. For cleaning new components, the passage is exposed to the outside and there is a possibility of foreign substances which may intrude into the passage from an external atmosphere even though new components are cleaned. A treating solution for wafers made of silicon or the like in semiconductor device manufacturing process need be able to filter foreign substances contained in the solution as in a clean room and therefore work accompanying intrusion of foreign substances into the passage should be avoided. In addition, a chemical solution always leaks whenever the fluid heater is mounted and dismantled to adhere to other components and an operator's body to result in a cause of corrosion and hazard to health. To prevent such leakage, the

chemical solution should be removed in advance from the fluid heating pipe unit and it is a troublesome work. Fluids for etching and removing the resist are contaminated due to stains of devices after repeated use and therefore should be periodically renewed by replacing them with fresh fluids. In this case, the internal tube of the fluid heating pipe unit which has a high temperature is directly exposed to a low temperature fluid before heating and subjected to large thermal impact and this will therefore be a cause of remarkable reduction of the service life. This tendency is further larger in the configuration shown in Figs.11(A) and (B). In other words, the electric heater 2 surrounded by insulation material 4 maintains a high temperature for a long time even after the current supply has been stopped. The inventor of the present invention has confirmed that, if fluid C is removed and new fluid C before heating is introduced into the heating pipe, this new fluid C is boiled on the surface of the heating pipe 1 to produce a great volume of vapor and the fluid heating pipe unit 1 would be broken by thermal impact due to boiling and vapor pressure.

#### Disclosure of the Invention

The first object of the present invention made in view of the above described problems of the prior art is to provide a fluid heater which has a high energy density structure and an increased radiation receiving area. In addition, the second object is to provide a fluid heater which facilitates maintenance services and excels in prevention of intrusion of contamination sources.

To attain the above first object, the fluid heater in accordance with the present invention has a fluid heating pipe unit provided on the external periphery of the electric heater and an inwardly faced reflection member provided on the external periphery of this fluid heating pipe unit, which is made of a transparent member.

The fluid heating pipe unit provided on the external periphery of the electric heater can be constructed with a transparent member at the electric heater side and an inwardly faced reflection member on the outside.

In addition, this fluid heating pipe unit can be formed with a radiant heat absorbing member instead that the outside of the electric heater is formed with the inwardly faced reflection member.

Moreover, the electric heater is U-shaped and the fluid heating pipe unit is formed in a semi-circular shape in which a reflector plate is provided and this U-shaped electric heater can be housed in a concaved space of the semi-circular fluid heating pipe unit.

The reflection surface of the inwardly faced reflection member on the outside of the fluid heating pipe unit and the reflection surface of the inwardly faced reflection member provided on the external periphery of the radiant heat absorbing member are formed with a light reflective film made of gold, aluminium, tin oxide, indium, or chromium.

To attain the above second object, the fluid heater in accordance with the present invention has an electric heater which is a quartz glass tube type infrared ray heater, a fluid heating pipe unit which consists of a transparent quartz glass tube at the electric heater side and a fluororesin tube, which is a radiant heat absorbing member at the external side whereby both ends of this quartz glass tube are fitted into holes provided in both end closing walls of the fluororesin tube. The cross section of the external profile of the fluid heating pipe unit can be polygonal.

The fluid heater is arranged in a housing, which can be inwardly covered with a light reflection film made of gold, aluminium, tin oxide, indium or chromium.

In the structure as described above, radiant heat from the electric heater is basically radiated to the fluid heating pipe unit to heat fluid. Fluid penetrating radiant heat, which has not contributed to initial heating of fluid, penetrates the outside of the fluid heating pipe unit and radiated by the inwardly faced reflection member which is externally provided in an annular shape, then penetrates again outside the fluid heating pipe unit to be re-radiated into fluid, thereby fluid is heated again.

Fluid penetrating radiant heat is re-reflected into fluid without penetrating the outside of the fluid heating pipe unit to re-heat fluid when the outside itself is formed as the inwardly faced reflection member. Or when fluid penetrating radiant heat is absorbed by the radiant heat absorbing member on the outside of the fluid heating pipe unit, radiant heat subsequently re-heats fluid as conduction heat.

Since the fluid heating pipe unit is formed with anticorrosive materials which are a quartz glass tube and a fluororesin tube, the anticorrosiveness of the fluid heating pipe unit and low contaminativeness of fluid to be heated are improved. The electric heater formed as a quartz glass type infrared ray heater withstands high temperatures and maintainability is improved.

In addition, the reflection surface of the inwardly faced reflection member and the reflection surface of the inwardly faced reflection member provided on the external periphery of the radiant heat absorbing member are formed as a light reflection film made of gold, aluminium, tin oxide, indium and chromium to prevent leakage of the

penetrating radiant heat and re-radiate to fluid, thus making the radiant heat re-contribute to heating of fluid.

Moreover, an internal pipe of a transparent fluid heating pipe unit, which is open-ended at both ends, can be disposed in an external pipe of a fluid heating pipe unit, which is provided with a fluid inlet and a fluid outlet in the pipe wall and open-ended at both ends, with a space left between the internal wall of the external pipe and the internal pipe of the transparent fluid heating pipe unit. In addition, both ends of these external and internal pipes can be connected each other as sealed, an electric heater can be arranged in the internal pipe with a space left therebetween and both ends of this electric heater can be supported by supporting members.

The U-shaped electric heater can be housed in the U-shaped space formed by the semi-circular fluid heating pipe unit, this fluid heating pipe unit can be arranged in a housing and both ends of the U-shaped electric heater can be supported by the supporting members on the cap provided on this housing..

This configuration allows to remount only the electric heater onto/from the fluid heater and therefore fluid need not be removed in advance from the fluid heating pipe unit when fluid is to be replaced, maintenance is facilitated and intrusion of contaminative substances can be prevented.

#### Brief Description of the Drawings

Fig.1 (A) is a perspective view of a fluid heater of the first embodiment in accordance with the present invention and Fig.1 (B) is a sectional view of the fluid heater,

Fig.2 (A) is a perspective view of a fluid heater of the second and third embodiment in accordance with the present invention and Fig.2 (B) is a sectional view of the fluid heater,

Fig.3 (A) is a perspective view of a fluid heater of the fourth embodiment in accordance with the present invention and Fig.3 (B) is a sectional view of the fluid heater,

Fig.4 (A) is a perspective view of a fluid heater of the fifth embodiment in accordance with the present invention and Fig.4 (B) is a sectional view of the fluid heater,

Fig.5 (A) is a perspective view of a fluid heater of the sixth embodiment in accordance with the present invention and Fig.5 (B) is a sectional view of the fluid heater,

Fig.6 (A) is a perspective view of a fluid heater of the tenth embodiment in accordance with the present invention and Fig.6 (B) is a sectional view of the fluid heater,

Fig.7 is a perspective view of a fluid heater of the eleventh embodiment in accordance with the present invention,

Fig.8 (A) is a sectional view of a fluid heater according to the 12th embodiment, Fig.8 (B) is a front view of the end part of the electric heater, Figs.8 (C1) and (C2) are respectively a front view and a side view of a cap,

Figs. 8 (D1) and (D2) are respectively a front view and a side view of a first ring,

Figs. 8 (E1) and (E2) are respectively a front view and a side view of a second ring,

Fig.9 (A) is a sectional view of a fluid heater according to the 13th embodiment, Fig.9 (B) is a front view of a cap and Figs. 9 (C1) and (C2) are respectively a front view and a side view of the ring,

Fig.1 is a perspective view showing an example of appropriate use of the fluid heater, and

Fig.11 is a perspective view of a conventional fluid heater and Fig.11 (B) is a sectional view of this fluid heater.

#### Best Mode for Carrying Out the Invention

The best embodiment of a fluid heater in accordance with the present invention is described in detail below referring to the accompanying drawings.

Figs.1 (A) and (B) respectively show the first embodiment of the present invention wherein a fluid heating pipe unit 1 is provided on an external periphery of electric heater 2 and, in addition, an inwardly faced reflection member 5 is provided on an external periphery of this fluid heating pipe unit 1. This fluid heating pipe unit 1 is roughly formed with internal and external tubes made of a quartz glass tube. Specifically, the fluid heating pipe unit is provided with fluid inlet pipe 31 and fluid outlet pipe 32 at right and left sides and the electric heater 2 along the center axis in a space 71 in the internal tube 11. It is confirmed in the experiments by the inventor of the present invention that, though there is air in this space 71, light is rarely absorbed by air and a greater part of radiant heat from the electric heater 2 is radiated into the fluid heating pipe unit 1 to contribute to heating of fluid.

Figs. 2 (A) and (B) respectively show a fluid heater according to the second embodiment which is provided with the fluid heating pipe unit 1 on the external periphery of the electric heater 2. Differing from the first embodiment, the inwardly faced reflection member 5 is not provided on the external periphery of the fluid heating pipe unit 1 and the outside of the fluid heating pipe unit 1 is formed with the inwardly faced reflection member 12b.

As the third embodiment, the outside of the fluid heating pipe unit 1 can be formed with a

radiant heat absorbing member 12c such as, for example, a black-colored member instead of the inwardly faced reflection member 12b in Figs.2 (A) and (B).

Figs.3 (A) and (B) respectively show the fourth embodiment. The fluid heating pipe unit 1 is semi-spherically shaped, the electric heater side 11 of the fluid heating pipe unit 1 is formed with transparent material and the outside is coated with a reflection member 12b or a radiant heat absorbing member 12c. The electric heater 2 is housed in the U-shaped space of the fluid heating tube unit 1 and its upper part is covered with a reflection plate 5.

In the fifth embodiment shown in Figs.4 (A) and (B), the electric heater 2 is a quartz glass type infrared ray heater. The fluid heating pipe unit 1 incorporates this quartz glass type infrared ray heater. The fluid heating pipe unit 1 is provided with a quartz glass tube 11 at the quartz glass type infrared ray heater 2 side, an external fluororesin tube 12d and sealing member 6, and the quartz glass tube 11 is fitted to the holes of the closing walls of both ends of the fluororesin tube 12d with sealing members 6.

Figs.5 (A) and (B) respectively show the sixth embodiment wherein the outside of the fluid heating pipe unit 1 is square-shaped to improve the stability of the fluid heater itself, though it is cylindrically shaped in the fourth embodiment. Various modes of this outside profile are available because of polygonal cross section.

Since contamination substances adhere to the flow passage if there is unevenness in the flow passage, the surface of the fluororesin tube 12c should be flat. Unevenness appears on the cut surface which is usually made by cutting but the tube 12c can be obtained as an injection-molded product with high flatness free from pin holes by using fluororesin sold with the brand name SAITOP by Asahi Glass Co., Ltd. For a fluid to be heated which is a hydrofluoric acid based reagent, the flow passage should be made of fluororesin. SAITOP fluororesin can be coated on the surface of quartz glass and the flow passage side surface of the quartz glass tube 11 can be coated with SAITOP. Since the light transmission factor of SAITOP from the visible zone to the infrared ray zone is 95~96%, thin film coating of several hundreds angstrom to several tens micron is enabled and simultaneously the coating of SAITOP on the flow passage side surface of the quartz glass tube 11 does not hinder transmission of light.

The reflection surfaces of the inwardly faced reflection members 5 and 12b shown in the first and second embodiments are covered with gold. These reflection surfaces can be covered with light reflection material such as aluminium, tin oxide, indium, chromium or the like, in addition to gold

(the seventh and eighth embodiments).

An inwardly reflection member can be additionally provided on the external periphery of the external radiant heat absorbing member 12c shown in the third embodiment and this reflection surface can be covered with gold. Also in this case, the reflection surface can be covered with light reflection material such as aluminium, tin oxide, indium, chromium or the like (the ninth embodiment).

In the tenth embodiment, as shown in Figs.6 (A) and (B), the fluid heater is arranged in the housing 8 which is inwardly covered with light reflection material such as gold, aluminium, tin oxide, indium, chromium or others so that the fluid heater is partly covered. As shown in Fig.7, the housing can be a complete housing which wholly covers the fluid heater (the 11th embodiment). In this case, "inwardly faced" means that the reflection surface is faced to the inside where the fluid heater is arranged though this covering film is used on the external surface, internal surface or internal and external surfaces.

According to the above embodiments, basically, the fluid heating pipe unit 1 is provided on the external periphery of the electric heater 2 to heat fluid in the fluid heating pipe unit 1.

In case of the conventional fluid heater, a radiant heat component from the external periphery of the electric heater 2 is not radiated to the fluid heating pipe unit 1 and is only radiated to insulation material 4 and therefore it is difficult for this radiant heat component to contribute to heating of fluid. On the contrary, in cases of the above described embodiments, all radiant heat is basically radiated to the fluid heating pipe unit 1 and accordingly high speed heating is carried out. In addition, since insulation material indispensable for the conventional fluid heater is omitted, a space required can be reduced. In other words, a high energy density structure is obtained for the same heating calorie and the radiation receiving area is increased.

In addition, the fluid heating pipe unit 1 is made of quartz glass and fluororesin and therefore anticorrosiveness of the fluid heating pipe unit 1 can be improved. Since the fluororesin tube is made as an injection molded product, its surface can be smoothed to avoid adhesion of fluid and contamination of heated fluid can be reduced.

The electric heater 2 is a quartz glass infrared ray heater, for example, a halogen lamp which provides a filament temperature of 2000K~3000K, and can therefore be used at a high temperature approximately two or three times the filament temperature of the nichrome wire the limit for which is approximately 1000K and radiation light energy can be improved to 16~81 times. The existing reflection surfaces and the reflection surfaces separately pro-

vided are covered with gold, aluminium, tin oxide, indium, chromium or the like material as a light reflection film to prevent penetration of radiant heat to outside.

In addition to the above, the electric heater 2 and the internal transparent member 11 of the fluid heating pipe unit 1 are disposed opposing each other with a clearance 7 and the both ends of the electric heater 2 are remountably fitted to the fluid heating pipe unit 1 with supporting members. This structure is shown in detail in Figs.8 and 9 as the 12th and 13th embodiments.

In Fig.8 (A), the electric heater 2 is a halogen lamp. In the quartz glass tube 21 with both ends which are formed to be flat after melting and cooling, halogen element, inactive gas 23 and a tungsten filament coil 25 supported by a plurality of anchors 24 are sealed. A molybdenum foil 26 is sealed inside both ends 22 and the filament coil 25 and a lead 27 inserted from the outside are connected to this molybdenum foil 26. The details of the electric heater 2 and coupling of internal tube and external tube 12 are as described below.

The coupling relationship of the electric heater 2 and the internal tube 11 is shown. The internal tube 11 incorporates the electric heater 2 and ceramic rings 91 and 92 serving as supporting members in sequence from the center and capped with silicone rubber bushes 93. Both ends 22 shown in Figs.8 (B) of the electric heater 2 are inserted into a recesses 911 of the ceramic rings 91 shown in Figs.8 (E1) and (E2). A lead 27 is connected to an external power supply through the recesses 921 of ceramic rings shown in Figs.8 (D1) and (D2) and through holes 931 of silicone rubber bushes 93 shown in Fig.8 (C1) and (C2). Ceramic rings 91 and 92 are used to provide a certain amount of clearance in the lengthwise direction of the internal tube 11 and also in the radial direction while the electric heater 2 is housed in the internal tube 11. Therefore, ceramic rings 91 and 92 are loosely inserted into the internal tube 11 as shown in Fig.8 (A). A difference of thermal expansion between the electric heater 2 and the internal tube 11 is absorbed by the above described clearance.

The coupling relationship of the internal tube 11 and the external tube 12 is shown. A member 94 provided a through hole through which the internal tube 11 is inserted at the center and a ferrule 95 to be used between the internal tube 11 and the external tube 12 are prepared. A female thread is provided at one end of the member 94 and a male thread is provided on both ends of the external tube 12. The internal tube 11 and the electric heater 2 are fixed to the external tube 12 by fitting the ferrule 95 onto the groove of external tube 12 and thread-fitting the member 94 and the external tube 12. The ferrule 95 is made of thermal resistant

fluororesin and serves to seal fluid to be heated and absorb the difference of thermal expansion of internal and external tubes 11 and 12.

According to the above embodiment, the electric heater 2 is remountably inserted into the internal tube 11 and therefore fluid (chemical solution) need not be removed from the fluid heating pipe unit 1 when the electric heater 2 is to be replaced, maintenance services are facilitated and intrusion of contamination substances into the flow passage can be prevented. In addition, fluid to be heated is not directly exposed to a high temperature electric heater 2 and therefore thermal impact to the electric heater 2 can be reduced and its longer service life can be ensured. The service life relates to the filament temperature, and the specified values are 3000 hours for 2800K and 1500 hours for 3000K and the cycle of replacement is once per 0.5~1 year. A plurality of electric heaters are often used and the cycle of replacement will be further longer.

In case of the U-shaped electric heater, the fluid heater is arranged in the housing 8 as shown Figs. 9 (A), (B), (C1) and (C2), the U-shaped electric heater 2 is fitted to the groove 951 of the rubber ring 95 via the through hole of the reflection plate 5 and the through hole 941 of the cap 94, and the ring 95 is fitted to the cap 94 with bolt 952. Also in this case, the electric heater 2 is easily remountable and inserted with a play owing to the elasticity of the rubber ring 95 serving as a supporting member and therefore thermal expansion of the electric heater 2 is absorbed and will not be damaged due to local load resulting from thermal expansion. This embodiment can apply to a pot for potable water.

#### Industrial Applicability

The present invention provides a useful fluid heater capable of having a high energy density structure and an increased radiation receiving area, facilitating maintenance services and preventing intrusion of contamination substances. Particularly, the fluid heater in accordance with the present invention is excellent as a fluid heater capable of appropriately carrying out heating and temperature control such as heating and temperature control of etching solution and resist removing solution after cleaning wafers made of silicon or the like in manufacturing processes of semiconductor devices, and heating and temperature control of oils for food-stuffs while the fluid to be heated is being supplied.

#### Claims

1. A fluid heater characterized to have a structure in which a fluid heating pipe unit is provided on an external periphery of an electric heater,

an inwardly faced reflection member is provided on an external periphery of said fluid heating pipe unit, and said fluid heating pipe unit is made of transparent material.

2. A fluid heater characterized to have a structure in which a fluid heating pipe unit is provided on an external periphery of an electric heater, said fluid heating pipe unit being made of transparent material at the electric heater side and an inwardly faced reflection member at its outside.
3. A fluid heater characterized to have a structure in which a fluid heating pipe unit is provided on an external periphery of an electric heater, said fluid heating pipe unit being made of transparent material at the electric heater side and a radiant heat absorbing member at its outside.
4. A fluid heater in accordance with Claim 2 or 3, wherein said electric heater is U-shaped, said fluid heating tube unit is formed in an approximately semi-circular shape with a reflection plate included therein, said U-shaped electric heater being housed in a recess of an approximately semi-circular shaped fluid heating pipe unit.
5. A fluid heater in accordance with Claim 3, wherein the outside of said fluid heating pipe unit has a polygonal cross section.
6. A fluid heater in accordance with Claim 1 or 2, wherein the reflection surface of the inwardly faced reflection member on the external periphery or the outside of said fluid heating pipe unit is formed with a light reflection film made of gold, aluminium, tin oxide, indium, chromium or the like.
7. A fluid heater in accordance with Claim 3, wherein an inwardly faced reflection member is further provided on the external periphery of the radiant heat absorbing member provided on the outside of said fluid heating pipe unit and the reflection surface of said inwardly faced reflection member is formed with a light reflection film made of gold, aluminium, tin oxide, indium, chromium or the like.
8. A fluid heater in accordance with Claim 3, wherein said electric heater is a quartz glass tube type infrared heater and said fluid heating pipe unit comprises a transparent quartz glass tube and a fluororesin tube the outside of which is formed with a radiant heat absorbing

member, said quartz glass tube being inserted into holes provided in closing walls at both ends of said fluororesin tube with a sealing member.

9. A fluid heater in accordance with Claim 1 or 2, wherein said fluid heater is arranged in a housing, said housing being inwardly covered with a light reflection film made of gold, aluminium, tin oxide, indium, chromium or the like.
10. A fluid heater characterized in that an internal pipe of a transparent fluid heating pipe unit, which is open-ended at both ends, is disposed in an external pipe of a fluid heating pipe unit, which is provided with a fluid inlet and a fluid outlet in the pipe wall and open-ended at both ends, with a space left between the the internal wall of the external pipe and the internal pipe of the transparent fluid heating pipe unit, both ends of these external and internal pipes are connected each other as sealed, an electric heater is arranged in the internal pipe with a space left therebetween and both ends of this electric heater are supported by supporting members in said internal pipe.
11. A fluid heater in accordance with Claim 4, wherein said U-shaped electric heater is housed in a U-shaped space of an approximately semi-circular fluid heating pipe unit, said fluid heating pipe unit is arranged in the housing, and both ends of said U-shaped electric heater are supported with supporting members on a cap provided on the upper part of said housing.

FIG.1(A)

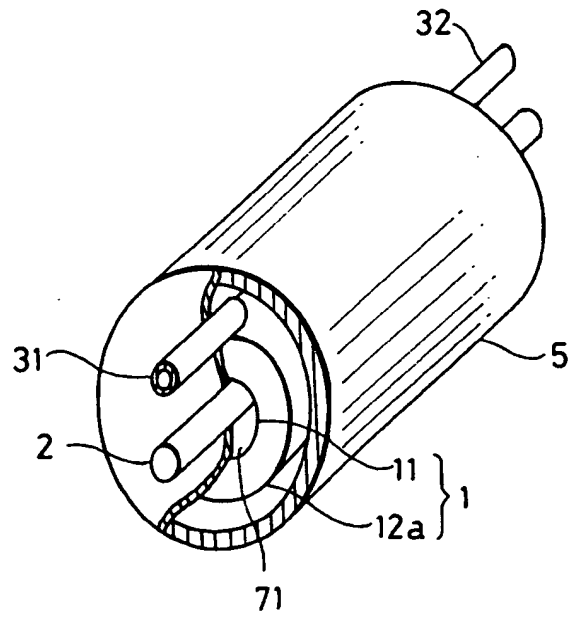


FIG.1(B)

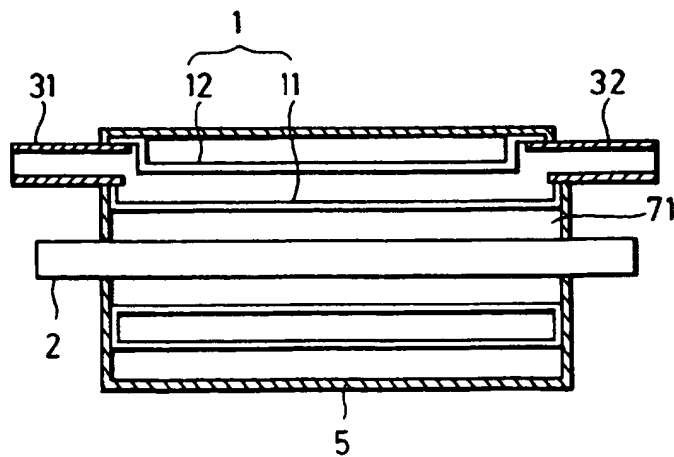




FIG. 2(A)

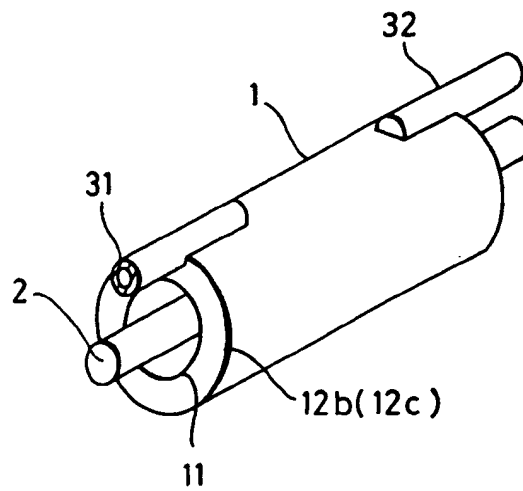


FIG. 2(B)

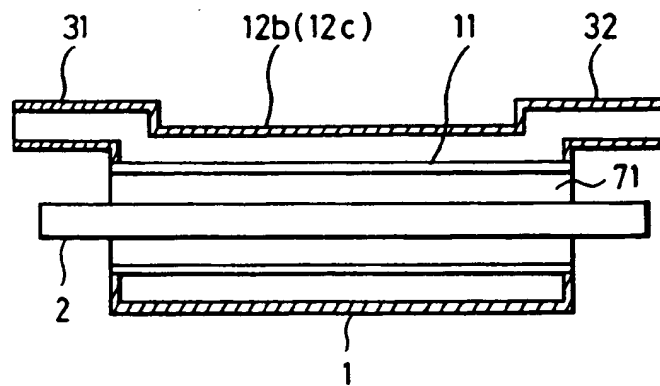


FIG. 3(A)

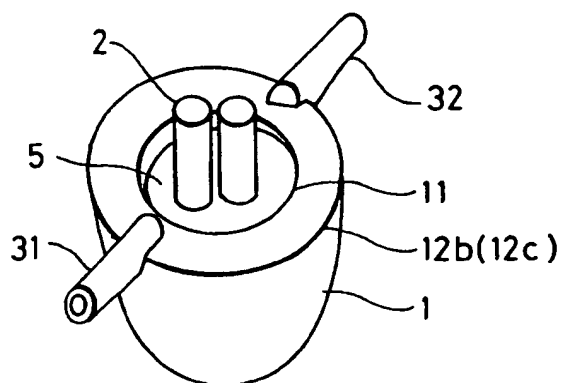


FIG. 3(B)

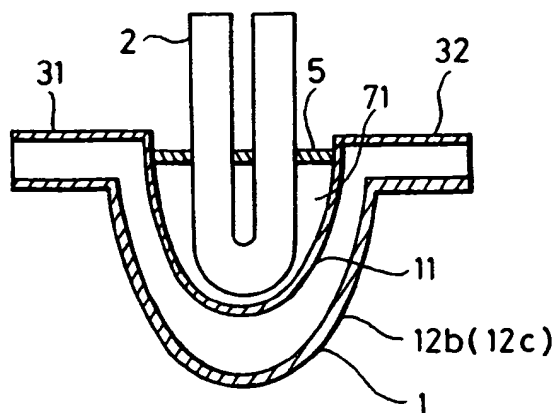


FIG. 4(A)

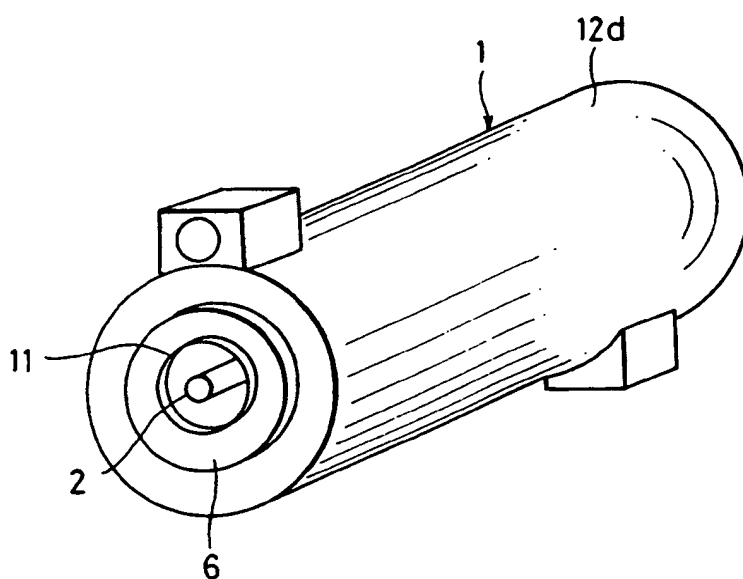


FIG. 4(B)

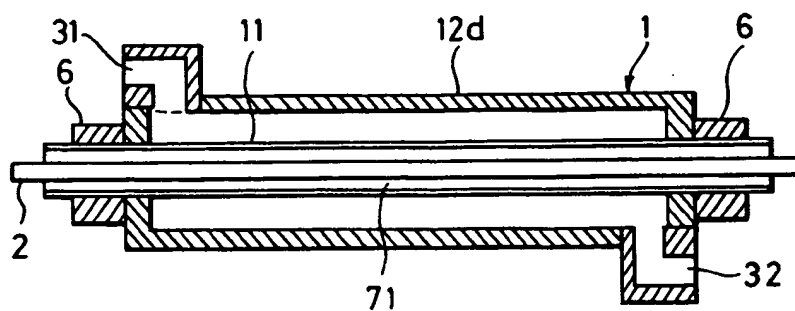


FIG. 5(A)

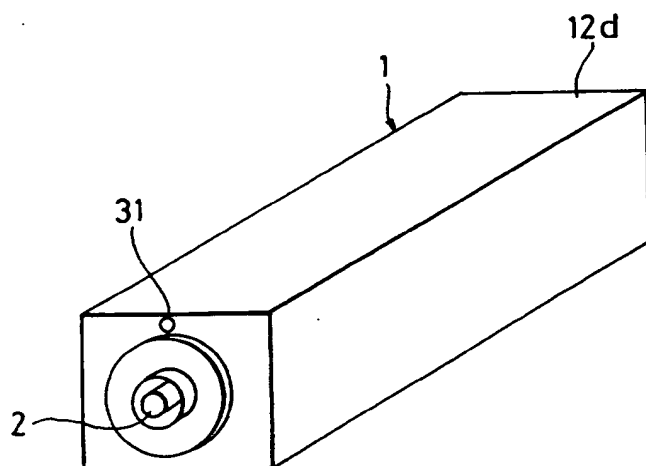


FIG. 5(B)

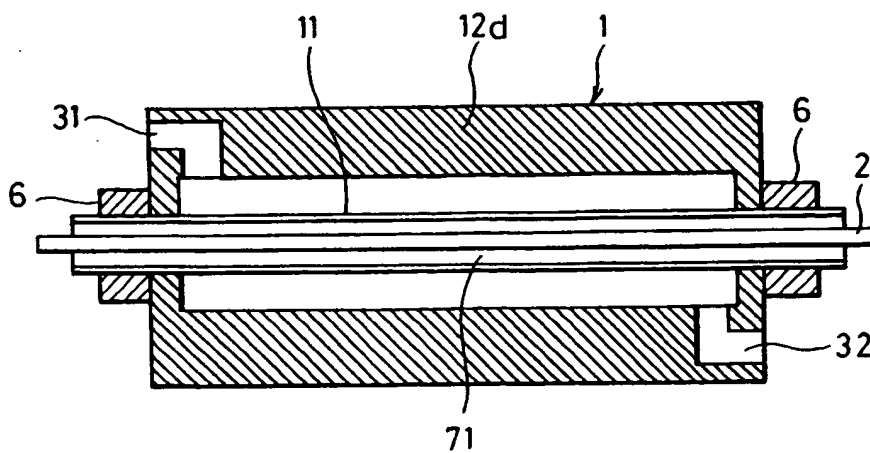


FIG. 6(A)

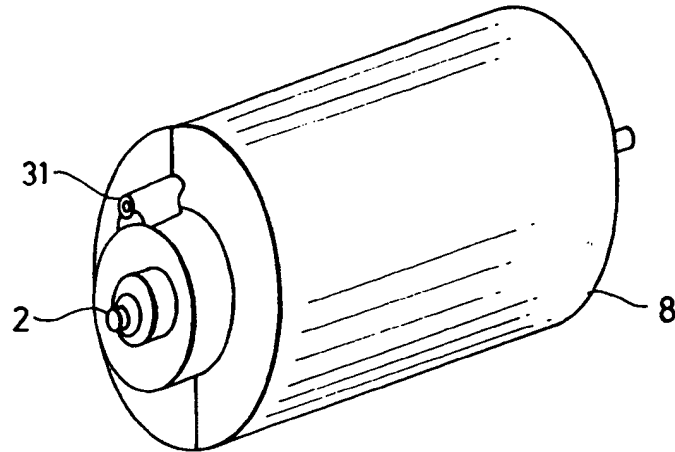


FIG. 6(B)

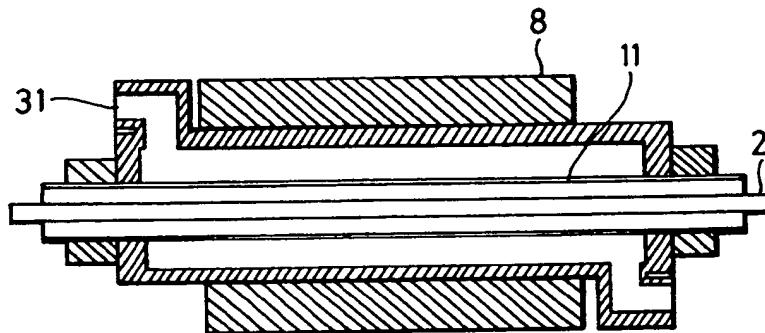


FIG. 7

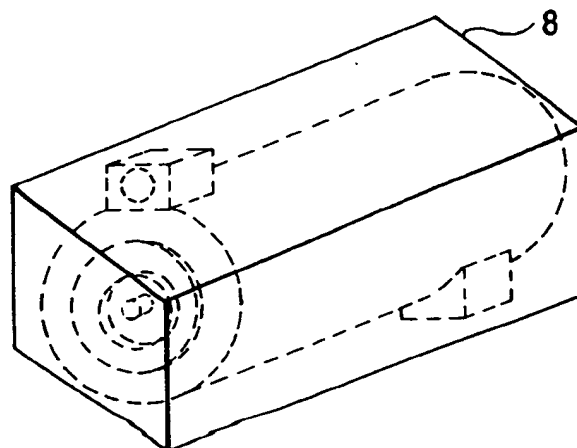


FIG. 8(A)

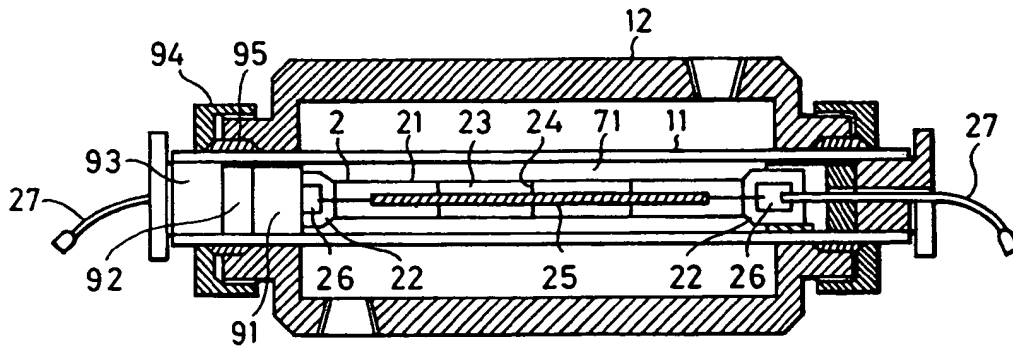


FIG. 8(B)

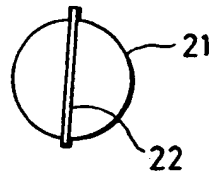


FIG. 8(C1)

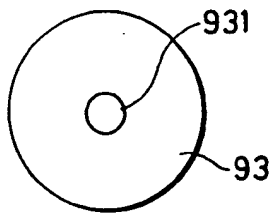


FIG. 8(D1)

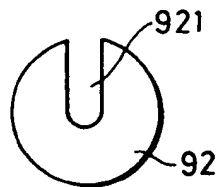


FIG. 8(E1)

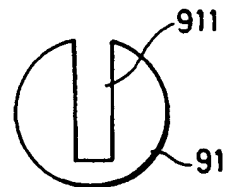


FIG. 8(C2)

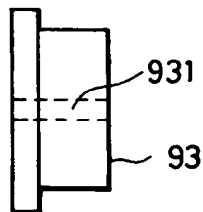


FIG. 8(D2)

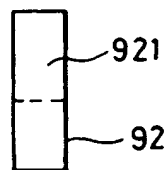


FIG. 8(E2)

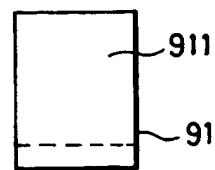


FIG. 9(A)

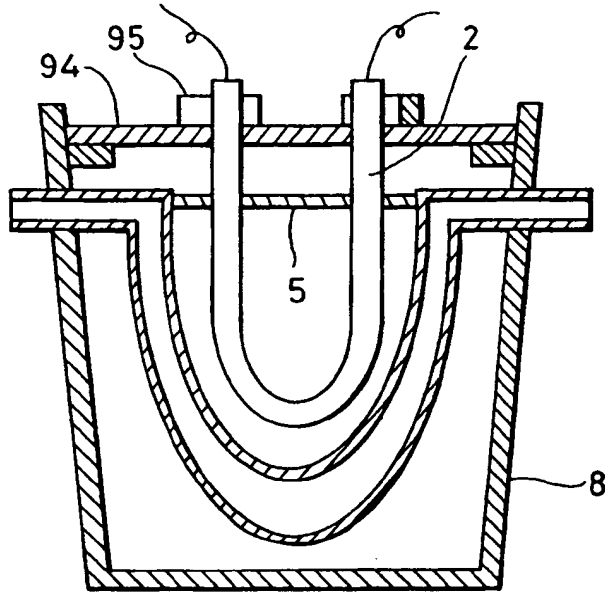


FIG. 9(B)

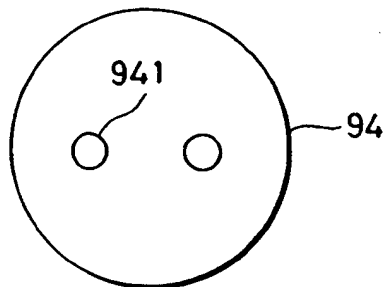


FIG. 9(C1)

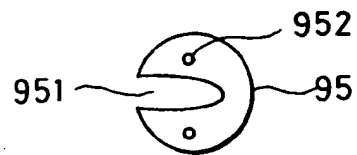
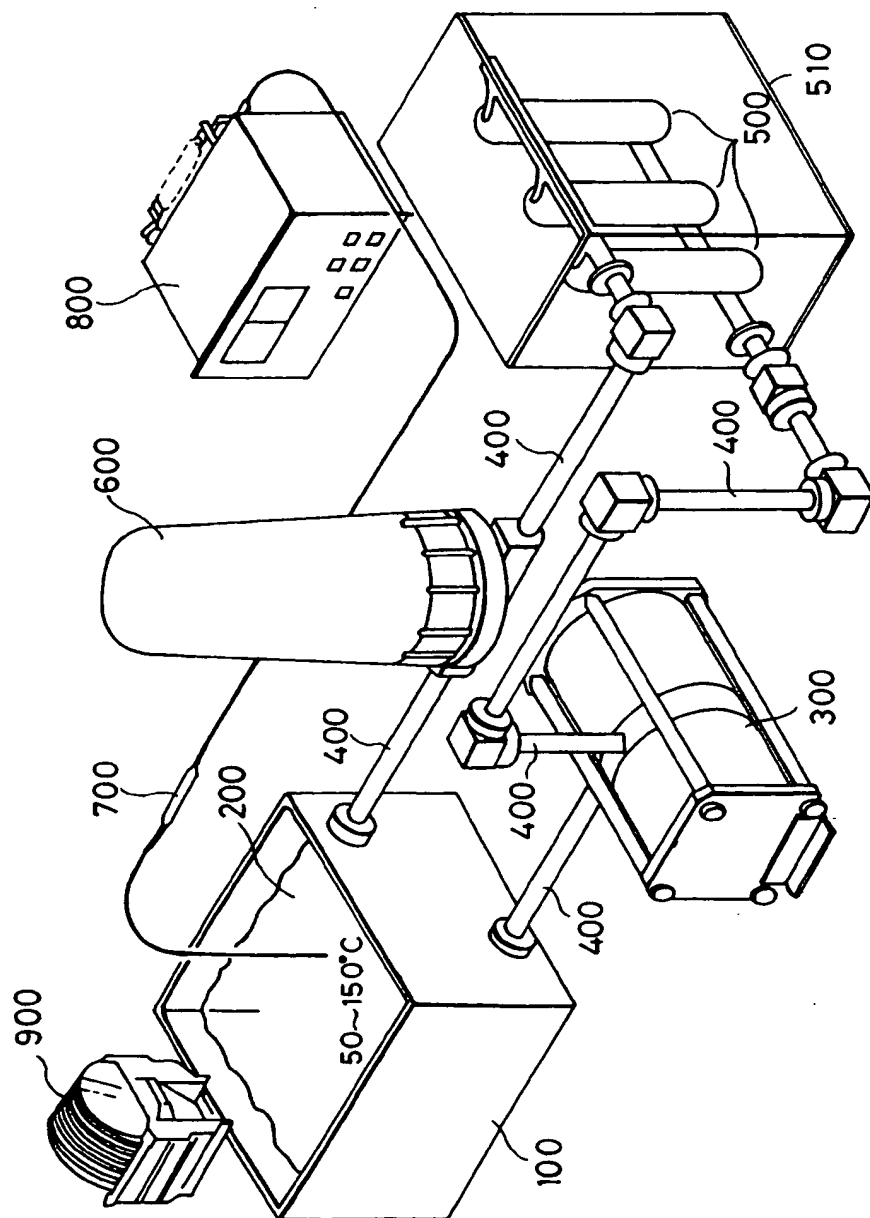


FIG. 9(C2)



FIG.10





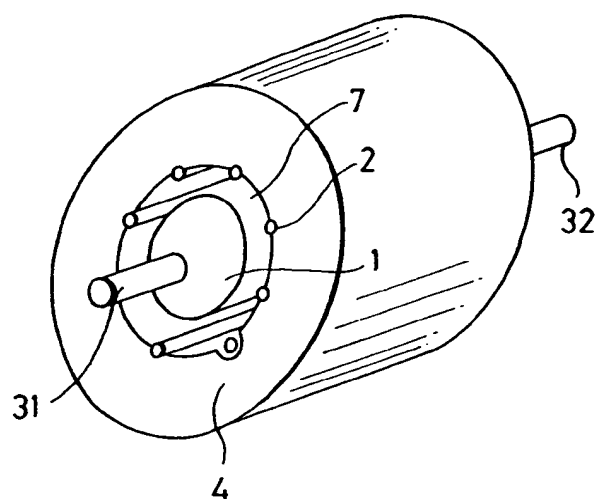
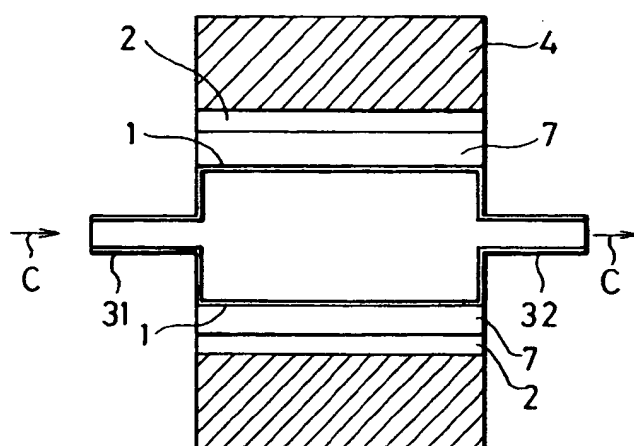


FIG .11(B)



# INTERNATIONAL SEARCH REPORT

International Application No. PCT/JP92/00086

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>1</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl <sup>5</sup> F24H1/10		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
IPC	F24H1/10-1/16	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched <sup>8</sup>		
Jitsuyo Shinan Koho	1926 - 1992	
Kokai Jitsuyo Shinan Koho	1971 - 1992	
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>1</sup></b>		
Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	JP, Y1, 40-712 (Matsushita Electric Ind. Co., Ltd.), January 11, 1965 (11. 01. 65), (Family: none)	1, 2, 3, 6, 8, 10
A	JP, U, 2-55047 (Daihen K.K. and another), April 20, 1990 (20. 04. 90), (Family: none)	5
A	JP, Y1, 39-2664 (TDK Corp.), February 3, 1964 (03. 02. 64), (Family: none)	10
<p><sup>14</sup> Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
April 20, 1992 (20. 04. 92)	May 12, 1992 (12. 05. 92)	
International Searching Authority	Signature of Authorized Officer	
Japanese Patent Office		

Form PCT/ISA/210 (second sheet) (January 1983)

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